ASME B133.8 77 ■ 0759670 0041603 0 ■

W-25-10

AMERICAN NATIONAL STANDARD

Gas Turbine Installation Sound Emissions

ANSI B133.8 - 1977

SECRETARIAT

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

PUBLISHED BY

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

United Engineering Center 345 East 47th Street New York, N. Y. 10017

Copyright ASME International
Provided by IHS under license with ASME
No reproduction or networking permitted without license from IHS

Not for Resale

No part of this document may be reproduced in any form, in an electronic retrieval system or otherwise, without the prior written permission of the publisher.

Copyright © 1977 by
THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
All Rights Reserved
Printed in U.S.A.

Copyright ASME International
Provided by IHS under license with ASME
No reproduction or networking permitted without license from IHS

Not for Resale

FOREWORD

The purpose of the B133 standards is to provide criteria for the preparation of gas turbine procurement specifications. These standards will also be useful for response to such specifications.

The B133 standards provide essential information for the procurement of gas turbine power plants. They apply to open cycle, closed cycle, and semi-closed cycle gas turbines with conventional combustion systems for industrial, marine, and electric power applications. Auxiliaries needed for proper operation are covered. Not included are gas turbines applied to earth moving machines, agricultural and industrial-type tractors, automobiles, trucks, buses and aeropropulsion units.

For gas turbines using unconventional or special heat sources (such as: chemical processes, nuclear reactors, or furnaces for supercharged boilers), these standards may be used as a basis; but appropriate modifications may be necessary.

The intent of the B133 standards is to cover the normal requirements of the majority of applications, recognizing that economic trade-offs and reliability implications may differ in some applications. The user may desire to add, delete or modify the requirements in this standard to meet his specific needs, and he has the option of doing so in his own procurement specification.

The B133.8 standard specifies gas turbine installation sound emissions for industrial, pipeline and utility applications. Field sound measurement procedures to determine specified sound emission compliance and to report field data are also presented.

Suggestions for improvement of this standard will be welcome. They should be sent to The American Society of Mechanical Engineers, United Engineering Center, 345 East 47th Street, New York, NY 10017.

American National Standard B133.8 was approved by the B133 Standards Committee and final approval by the American National Standards Institute was granted on May 26, 1977.

Copyright ASME International
Provided by IHS under license with ASME
No reproduction or networking permitted without license from IHS
Not for Resale

AMERICAN NATIONAL STANDARDS COMMITTEE B133
Procurement Standards For Gas Turbines

(The following is the roster of the committee at the time of approval of this Standard)

OFFICERS

A. A. Hafer, *Chairman* **E. A. Borgmann,** *Vice Chairman*
Alan Bagner, *Secretary*

STANDARDS COMMITTEE

ACOUSTICAL SOCIETY OF AMERICA
R. M. Hoover, Chairman, Bolt, Beranek and Newman Incorporated, Houston, Texas
R. R. Audette, Alternate, Westinghouse Electric Corporation, Philadelphia, Pennsylvania

AIRCRAFT POROUS MEDIA, INCORPORATED
F. E. Bishop, Aircraft Porous Media, Incorporated, Glen Cove, New York

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, THE
A. A. Hafer, General Electric Company, Schenectady, New York
Vern Maddox, Alternate, Hydrocarbon Processing, Houston, Texas

BATTELLE MEMORIAL INSTITUTE
H. R. Hazard, Battelle Memorial Institute, Columbus, Ohio

CINCINNATI GAS AND ELECTRIC COMPANY
E. A. Borgmann, Cincinnati Gas and Electric Company, Cincinnati, Ohio

CONSOLIDATED EDISON COMPANY OF NEW YORK, INCORPORATED
A. M. Teplitzky, Consolidated Edison Company of New York, Incorporated, New York, New York

DOW CHEMICAL OF CANADA, LIMITED
J. P. Zanyk, Dow Chemical of Canada, Limited, Sarnia, Ontario, Canada

EBASCO SERVICES, INCORPORATED
T. C. Culyer, Ebasco Services, Incorporated, New York, New York

EDISON ELECTRIC INSTITUTE
J. E. Barry, Missouri Public Service Company, Kansas City, Missouri
G. A. Olson, Alternate, Edison Electric Institute, New York, New York

FEDERAL POWER COMMISSION
B. E. Biggerstaff, Federal Power Commission, Washington, D.C.
L. A. Schuppin, Alternate, Federal Power Commission, Washington, D.C.

GENERAL ELECTRIC COMPANY
R. L. Hendrickson, General Electric Company, Schenectady, New York
A. N. Smith, General Electric Company, Greenville, South Carolina

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS
A. C. Dolbec, General Electric Company, Greenville, South Carolina
R. D. Miller, Alternate, Westinghouse Electric Corporation, Philadelphia, Pennsylvania

MECHANICAL TECHNOLOGY, INCORPORATED
P. E. Babson, Mechanical Technology, Incorporated, Latham, New York

PURDUE UNIVERSITY
M. R. LeCuyer, Purdue University, West Lafayette, Indiana

Copyright ASME International
Provided by IHS under license with ASME
No reproduction or networking permitted without license from IHS
Not for Resale

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS
Dr. D. A. Rains, Ingalls Shipbuilding Division, Litton Industries, Pascagoula, Mississippi

TRANSCANADA PIPELINE, LIMITED
D. G. Donaghey, Transcanada Pipeline, Limited, Toronto, Ontario, Canada

TURBODYNE CORPORATION
L. T. Brinson, Turbodyne Corporation, St. Cloud, Minnesota

TURBO POWER AND MARINE SYSTEMS
G. E. Edgerly, Turbo Power and Marine Systems, Farmington, Connecticut

U.S. DEPARTMENT OF COMMERCE
James Tremante, U.S. Department of Commerce, Washington, D.C.

USTAG FOR ISO/TC70/SC6
T. E. Stott, Stal-Laval, Incorporated, Elmsford, New York

WESTINGHOUSE ELECTRIC CORPORATION
S. M. DeCorso, Westinghouse Electric Corporation, Lester, Pennsylvania
A. Haftel, Westinghouse Electric Corporation, Lester, Pennsylvania

WOODWARD GOVERNOR COMPANY
K. A. Teumer, Woodward Governor Company, Fort Collins, Colorado

INDIVIDUAL MEMBER
R. A. Harmon, Consultant, Latham, New York

PERSONNEL OF TASK FORCE B133.8, GAS TURBINE SOUND

R. M. Hoover, Chairman, Bolt, Beranek and Newman Incorporated, Houston, Texas
A. M. Teplitzky, Vice Chairman, Consolidated Edision Company of New York, Incorporated, New York, New York
D. R. Hendrix, Secretary, Riley Beaird, Incorporated, Shreveport, Louisiana
R. R. Audette, Westinghouse Electric Corporation, Philadelphia, Pennsylvania
J. P. Buechler, Long Island Lighting Company, Hicksville, New York
G. F. Hessler, Jr., Energy Services, Incorporated, West Hartford, Connecticut
F. J. Montegani, Dr., NASA, Lewis Research Center, Cleveland, Ohio
M. I. Schiff, Industrial Acoustics Company, Incorporated, Bronx, New York
R. B. Tatge, General Electric Company, Schenectady, New York

Copyright ASME International
Provided by IHS under license with ASME
No reproduction or networking permitted without license from IHS
Not for Resale

CONTENTS

	Page
1. Scope & Applicability	1
1.1 Scope	1
1.2 Applicability	1
2. Sound Emissions Specification	1
2.1 Introduction	1
2.2 Environmental Sound Emissions Specification Procedures	1
2.3 Environmental Sound Emissions Specification Format	2
2.4 Occupational Sound Emissions Specification	2
3. Field Sound Measurement Procedures	3
3.1 Introduction	3
3.2 Qualifications	3
3.3 Gas Turbine Operation	3
3.4 Acoustic Environment	3
3.5 Sound Measurement Instruments	3
3.6 Microphone Locations	4
3.7 Sound Measurements	4
3.8 Data Reporting	4
3.9 Average Sound Level Calculation	4
3.10 Comparison of Measured and Specified Sound Level	5
Figure 1 — Sound Level Relative to that at 400 ft (120m) for Sound Measured in Octave Bands and Weighted with Networks	6
Figure 2 — Gas Turbine Sound Level Measurement Locations	7
Table 1 — Specified Sound Levels at 400 ft (120m) for Total Gas Turbine Installation at Contract Conditions	2
Table 2 — Corrections for Sound Reflecting Surfaces	5
Appendix A — Guide to Determine Acceptable A-Weighted Sound Level	8
Table A1 — Suggested Procedure to Develop Sound Level Specification at Standard Distance of 400 ft (120m)	9
Table A2 — Corrections for Background Sound	11
Table A3 — Residential Area Sound Levels	11
Table A4 — Operational Cycle Correction	12
Figure A1 — Community Reaction to Noises of Many Types as a Function of the Normalized Outdoor Day/Night Sound Level of the Intruding Noise	10
Figure A2 — Distance Correction for Weighted Sound Levels	13
Appendix B — Guide to Determine Specified C-Weighted Sound Level	14

Copyright ASME International
Provided by IHS under license with ASME
No reproduction or networking permitted without license from IHS
Not for Resale

GAS TURBINE INSTALLATION SOUND EMISSIONS

1. SCOPE & APPLICABILITY

1.1 Scope

1.1.1 This standard gives methods and procedures for specifying the sound emissions of gas turbine installations for industrial, pipeline, and utility applications. Included are practices for making field sound measurements and for reporting field data. This standard can be used by users and manufacturers to write specifications for procurement, and to determine compliance with specification after installation. Information is included, for guidance, to determine expected community reaction to noise.

1.2 Applicability

1.2.1 These procedures are applicable to land based, or shore side barge-mounted gas turbines in single or multiple arrangements, for indoor or outdoor stationary installations. Applications may include, but are not limited to gas turbine driven generators, compressors, or pumps, in simple cycle or combined cycle systems.

1.2.2 Gas turbines used for the primary or auxiliary propulsion source in transportation vehicles (airplanes, automotive, off-road vehicles, and ships, etc.), are excluded from this standard.

1.2.3 These procedures are intended to be used by gas turbine users and manufacturers. The procedure may be used to specify sound emission levels in accordance with local, state, or federal noise control requirements. A methodology is suggested in Appendices A and B to determine gas turbine installation sound emission levels that are generally compatible with the sound environment of a neighboring community.

1.2.4 Procedures outlined in Section 2 may be used to specify either the sound emissions from the gas turbine only, or the total sound emissions from the "site," including, but not limited to, gas turbine driven equipment and auxiliary equipment. The user's specification must clearly define the equipment for which the noise specification is applicable, especially for combined cycle plants where all equipment may not be furnished by the manufacturer. Unless otherwise stated, the specified noise emission limits shall include all equipment at the site provided by the manufacturer.

[1] Maximum sound level means the highest measured sound level at any point 400 ft (120m) from the turbine site perimeter in each of the nine octave bands, or the highest measured A- or C-weighted sound level.

[2] Average sound level is defined in Section 3.9.

2. SOUND EMISSIONS SPECIFICATION

2.1 Introduction

2.1.1 This procedure provides standard methods to specify gas turbine installation sound emissions for the purpose of complying with applicable environmental sound emission limits, or to comply with company standards, or to avoid unreasonable sound intrusions into the surrounding neighborhoods, or to conserve employee hearing.

2.2 Environmental Sound Emissions Specification Procedures

2.2.1 Gas turbine installation environmental sound emissions is specified by one of two alternate procedures. They include specifying either the octave band or both the A- and C-weighted sound levels at a standard a distance of 400 ft (120m) from the perimeter of the gas turbine(s). The gas turbine sound emission level can be determined for other far-field locations using Figure 1 (refer to 3.6.3).

Procedure A

This precedure requires specifying either the maximum[1] or the average[2] A-weighted sound levels. One suggested method to determine gas turbine installation sound emissions that are expected to be acceptable in a neighboring community is presented in Appendix A. Also, for installations where frame structures occupied by people are nearby, the A-weighted sound level alone does not adequately define permissible low frequency sound emissions. Thus, when using this procedure the permissible C-weighted level must also be specified. Suggestions for specifying the C-weighted sound level limit are given in Appendix B. A specification format is given in Table 1A.

Copyright ASME International
Provided by IHS under license with ASME
No reproduction or networking permitted without license from IHS
Not for Resale

Table 1

Specified Sound Levels At 400 ft (120m) For Total Gas Turbine Installation at Contract Conditions

Table 1A

Weighted Sound Levels in dB, re: 20 micropascals

	Overall	
	dB(C)	dB(A)
Sound Level at 400 ft (120m) *Average* or *Maximum*[1]		

[1] Specify either the *average* or the *maximum* levels to be achieved.

Table 1B

Octave Band Sound Levels in db, re: 20 micropascals

Center Frequency, in Hertz	31	63	125	250	500	1000	2000	4000	8000
Sound Level at 400 ft (120m) *Average* or *Maximum*[1]									

[1] Specify either the *average* or the *maximum* levels to be achieved.

Procedure B

This procedure requires specifying the maximum or average sound emission levels in each of nine specified octave bands. This procedure should be used when local or state regulations or user procedures set octave band sound limits. A specification format is shown in Table 1B.

2.3 Environmental Sound Emissions Specification Format

2.3.1 Where the manufacturer provides all the equipment in the gas turbine installation, a typical gas turbine installation environmental sound emissions specification is: "Sound emissions from the total gas turbine site including auxiliary equipment, when operated at rated megawatt or horsepower load in accordance with the contract specifications and ANSI B133.8 procedures, shall not exceed the *average* or *maximum* (choose one) A- and C-weighted sound level or any octave band sound level listed in Table 1, when measured at a distance of 400 ft (120m) from the perimeter of the nearest gas turbine. In the case where the manufacturer does not provide all of the equipment, the user shall specify the maximum or average *permissible* sound level emitted from all sources other than the manufacturer's equipment."

2.3.2 When specifying sound levels in either the nine specified octave bands or the A-weighted and C-weighted format, the following information should be contained within the purchase specification:

(1) Physical description and topographical plots of the ground surface.

(2) Dimension sketch showing gas turbine, measurement points, and significant building structures, or other sound reflecting objects (see paragraph 3.4.2).

(3) Seasonal average meteorological conditions, including: temperature, relative humidity, wind speed, and wind direction.

(4) ANSI type specification of all instruments to be used during final evaluation of gas turbine plant. (Refer to ANSI S1.4, Specification for Sound Level Meters).

(5) List of major site area sound sources existing at time of bid invitation.

2.4 Occupational Sound Emissions Specfication

Control or employee exposure to sound emissions from gas turbine(s), auxiliary equipment and driven devices is necessary to prevent hearing loss. Permissible A-weighted sound exposure limits have been promulgated by the U.S. Department of Labor pur-

Copyright ASME International
Provided by IHS under license with ASME
No reproduction or networking permitted without license from IHS

Not for Resale

suant to the Occupational Safety and Health Act, and by state labor departments. Refer to the *Federal Register* for current employee occupational sound exposure limits, or to applicable state regulations.

Where the manufacturer provides all of the equipment in the gas turbine installation, a typical gas turbine occupational sound emissions specification is:

"Sound levels from a gas turbine installation, auxiliary equipment and driven devices shall not exceed___*___ dB (A) when measured 3 ft (1m) in the horizontal plane and 5 ft (1.5m) from the ground or personnel platform from any major surface of the gas turbine, or its enclosure, or auxiliary equipment, or driven equipment, with the equipment operating at rated megawatt or horsepower load in accordance with contract specifications, and ANSI B133.8 procedures."

In the case where the manufacturer does not provide all of the equipment, the specified sound emissions shall only apply to the equipment furnished by the manufacturer.

3. FIELD SOUND MEASUREMENT PROCEDURES

3.1 Introduction

3.1.1 Standard procedures and equipment are described to measure gas turbine sound emissions under conditions found at installations in the field.

3.1.2 Procedures are defined to adjust measured data to a standand distance of 400 ft. (120m) from the gas turbine installation.

3.2 Qualifications

Gas turbine sound emissions are to be measured by an engineer, technician, or acoustical consultant qualified by experience or training.

3.3 Gas Turbine Operation

The gas turbine plant will include all construction features described in the purchase agreement, regardless of whether they are essential for operation. All gas turbines will be running at specified rated load in megawatts or horsepower. All enclosure doors and access panels will be closed unless otherwise specified.

3.4 Acoustic Environment

Numerous environmental factors affect the sound level measured at a specified orientation and distance relative to a gas turbine installation. These include weather, atmospheric temperature gradients, and the surrounding topography. Weather conditions are not controllable, but the measurement time should be chosen to minimize its effect. Terrain effects, including unlevel ground, wooded areas and reflecting objects are unique to each site, and they should be considered when selecting measurement position, and interpreting sound level measurements.

3.4.1 Atmospheric conditions. Measurements should not be made when the average wind velocity exceeds 7 mph (3m/sec) measured 5.0 ft (1.5m) above the ground. Cloudy or overcast, or nighttime conditions, are preferred.

3.4.2 The "normal" terrain condition is relatively flat topography with a hard, acoustically reflective surface, and with a line-of-sight between the measurement position and the gas turbine. When the terrain is not flat, or is not a hard reflective surface between the gas turbine and any measuring point, it shall be noted and described in the test report. Also, any large reflecting surfaces with dimensions greater than 10 ft and within 5λ of the source or within 5λ of the microphone (λ is the wave length at lowest frequency of interest (see 3.10)) should be noted in the report.

3.5 Sound Measurement Instruments

3.5.1 Sound level meter. Sound level measurements shall be made with a sound level meter that meets the requirements of the latest revision of ANSI S1.4-1971, Type 1 or 2. Type 1 is preferred.

3.5.2 Octave band filter set shall meet the requirements of the latest revision of ANSI S1.11, Specifications for Octave, Half-Octave and Third-Octave Band Filter Sets.

3.5.3 Tape recorder. If a magnetic tape recorder is used for data storage, it shall meet the provisions of the latest revision of ANSI S6.1, Qualifying a Sound Data Acquisition System. If there is a disagreement between directly measured sound level meter data and tape recorded data, the direct data shall take precedence.

3.5.4 Calibration. Instruments shall be acoustically calibrated using a sound level calibrator or pistonphone of known sound pressure level, both before and after each measurement series. A calibration level change exceeding ± 1.0 dB may require the test series to be repeated.

3.5.5 A microphone windscreen shall be used when making measurements. Its effect on the frequency

*To be filled in by user based on estimated employee noise exposure.

Copyright ASME International
Provided by IHS under license with ASME
No reproduction or networking permitted without license from IHS
Not for Resale

response of the sound level meter shall not exceed ± 0.5 dB at frequencies below 2,000 Hz, and ± 1 dB at frequencies from 2,000 to 10,000 Hz.

3.6 Microphone Locations

3.6.1 Microphone height. The microphone shall be located between 4 ft (1.2m) and 5 ft (1.5m) above the ground or personnel platforms.

3.6.2 Personnel exposure sound measurements, using the A-weighted network, shall be made at 3 ft (1m) from major surfaces of the gas turbine, around the periphery of the turbine or its enclosure, auxiliary equipment and driven device at intervals not exceeding 15 ft (5m), and at the point of maximum sound emissions.

3.6.3 Environmental sound measurements shall be made at the four (4) cardinal locations for a single gas turbine, and at eight (8) positions, 45 degrees apart, for multiple gas turbine installations, as shown on Figure 2. The air intake end of the gas turbine shall be designated as Position 1. The standard distance from the microphone to the nearest point on the base of the unit shall be 400 ft (120m). When the microphone cannot be located at this standard distance, an alternate measurement location shall be selected that shall not be less than 200 ft (60m) nor more than 600 ft (180m), or at a location specified in the purchase specifications or agreed to between the user and manufacturer. For installations where the standard measurement distance is in the acoustic near-field of a large multiple unit installation, the purchaser and seller shall mutually agree on a measurement location that is in the far-field (where the sound decreases at a rate of about 6 dB for doubling distance) of the noise sources.

3.6.4 Sound levels shall be reported at measurement locations specified in the purchase specifications. Measurements at distances other than 400 ft (120m) shall be adjusted as described in 3.9.2 to the sound level expected at the standard 400 ft (120m) distance.

3.7 Sound Measurements

3.7.1 General. The "slow" meter characteristic shall be used with the sound level meter. The measured Environmental Sound Level in each octave band with center frequencies from 31.5 to 800 Hz, or the A-weighted and C-weighted sound levels shall be reported as specified by Procedure A or B (refer to 2.2). The Occupational Sound Emissions (refer to 2.4) shall be reported as A-weighted sound levels.

3.7.2 Ambient sound levels. The ambient sound level at each position shall be measured using the A- and C-weighted networks, or each octave band, as required. Ambient sound level shall be measured and recorded before and after gas turbine sound emissions are measured. If the ambient sound is unsteady, its true rms sound pressure level shall be estimated following ANSI S1.13-1971 procedure, Section 8.4.2.1.

3.8 Data Reporting

The following information shall be included in the test report:

3.8.1 Gas turbine plant.

3.8.1.1 User.

3.8.1.2 Location.

3.8.1.3 Number of gas turbines and their model.

3.8.1.4 Load at time of sound measurements.

3.8.1.5 Date and time of measurements.

3.8.1.6 Description of gas turbine, driven equipment, auxiliary equipment and sound control treatment.

3.8.2 Acoustical Environment

3.8.2.1 Dimensioned sketch showing gas turbines measurement points, building, or other sound reflecting structures (see 3.4.2).

3.8.2.2 Physical and topographical description of the site.

3.8.2.3 Meteorological conditions at 5 ft (1.5m) above ground, including temperature, relative humidity, wind speed, and wind direction.

3.8.3 Instrumentation. Name, manufacturer, model number, serial number, and ANSI type of all sound measuring instruments used, and dates of last calibration. (refer to ANSI S1.4).

3.8.4 Acoustical data. All sound level measurements shall be reported to the nearest decibel.

3.8.5 A list of auxiliary equipment in operation should be made.

3.8.6 The names of the personnel who performed and observed the measurements should be reported.

3.9 Average Sound Level Calculation

3.9.1 Data correction. Measured sound levels at each location shall be corrected for the effect of measured ambient sound levels at each data location using Table 4 of ANSI S1.13-1971, Methods for the Measurement of Sound Pressure Levels, or latest

Copyright ASME International
Provided by IHS under license with ASME
No reproduction or networking permitted without license from IHS

Not for Resale

revision. If the sound level, with the gas turbine operating, does not exceed the ambient sound level by more than 3dB, the gas turbine sound level shall be considered to be the ambient level. In this case, if it is necessary to more clearly establish the actual turbine emission levels, the measurements may be repeated at a measurement position which is closer to the installation (see 3.6 for limitations), and/or at a time when the ambient sound levels can be expected to be lower, as verified by measurements made during the previous twelve months time period.

3.9.2 Data adjustment. Sound levels measured at distance other than 400 ft (120m) may be extrapolated to the standard distance after correction for ambient sound. Corrections for distance and air absorption are shown in Figure 1.

3.9.3 Data averaging. The corrected far-field sound levels at the four (4) or eight (8) locations shall be averaged[1] to yield the average sound level of the gas turbine installation at 400 ft (120m).

3.10 Comparison of Measured and Specified Sound Level

The sound emissions from the gas turbine installation shall be considered to be acceptable if: (one of the following four choices should be included in the contract document)

(1) the measured *average* or *maximum* sound level (whichever has been specified) is equal to or less than the specified A- weighted and C-weighted sound levels at the standard distance of 400 ft (120m), or

(2) the measured *average* or *maximum* sound level (whichever has been specified) in each of the nine octave bands, is equal to or less than the specified octave band sound level at the standard distance of 400 ft (120m), or

(3) the measured *average* or *maximum, weighted* or *octave band* sound levels, (whichever have been specified) is equal to or less than the specified levels at locations agreed to by the user and manufacturer. (This paragraph may apply to sites where there are significant and major reflecting structures such as buildings, or walls, or where it is not feasible or important to determine compliance at 400 ft (120m) due to hills, rivers, etc.), or

(4) the measured *average* or *maximum, weighted* or *octave band* sound levels, (whichever have been specified) should be equal to or less than the value specified except for the additive corrections given in Table 2. (These corrections only apply when there are major buildings, fences, or walls, or other large structures (see 3.4.2) within a distance of 5λ (λ wavelength of sound at lowest frequency of interest) of the turbine installation or the microphone location). If the specification is in the form of an A-weighted sound level, the lowest frequency of interest shall be 100 Hz. If C-weighted sound levels are specified, the lowest frequency of interest shall be 31.5 Hz.

Table 2

Corrections for Sound Reflecting Surfaces

Table 2A

Overall in dB, re: 20 Micropascals

dB(C)	dB(A)
5	3

Table 2B

Octave Band Corrections

Octave Band Levels in dB, re: 20 Micropascals

Center Frequency (Hz)		
31.5-125	250	500-8000
5	4	3

[1] The average sound level, $\overline{Le}$, is defined as the average sound level (rms) measured at either the four (4) or eight (8) locations. If the measured sound pressure level at the four (4) or eight (8) locations is within a three (3) dB range, the average may be computed by arithmetically averaging the measured sound levels. For any range in the data, the average is computed by the following formula:

$$\overline{Le} = 10 \log \frac{1}{N} \sum_{n=1}^{N} 10^{Ln/10} \qquad (1)$$

N = total number of measurements around the gas turbine installation (generally 4 or 8).

L_n = the weighted or octave band sound level at point n, in decibels.

Copyright ASME International
Provided by IHS under license with ASME
No reproduction or networking permitted without license from IHS

Not for Resale

Copyright ASME International
Provided by IHS under license with ASME
No reproduction or networking permitted without license from IHS

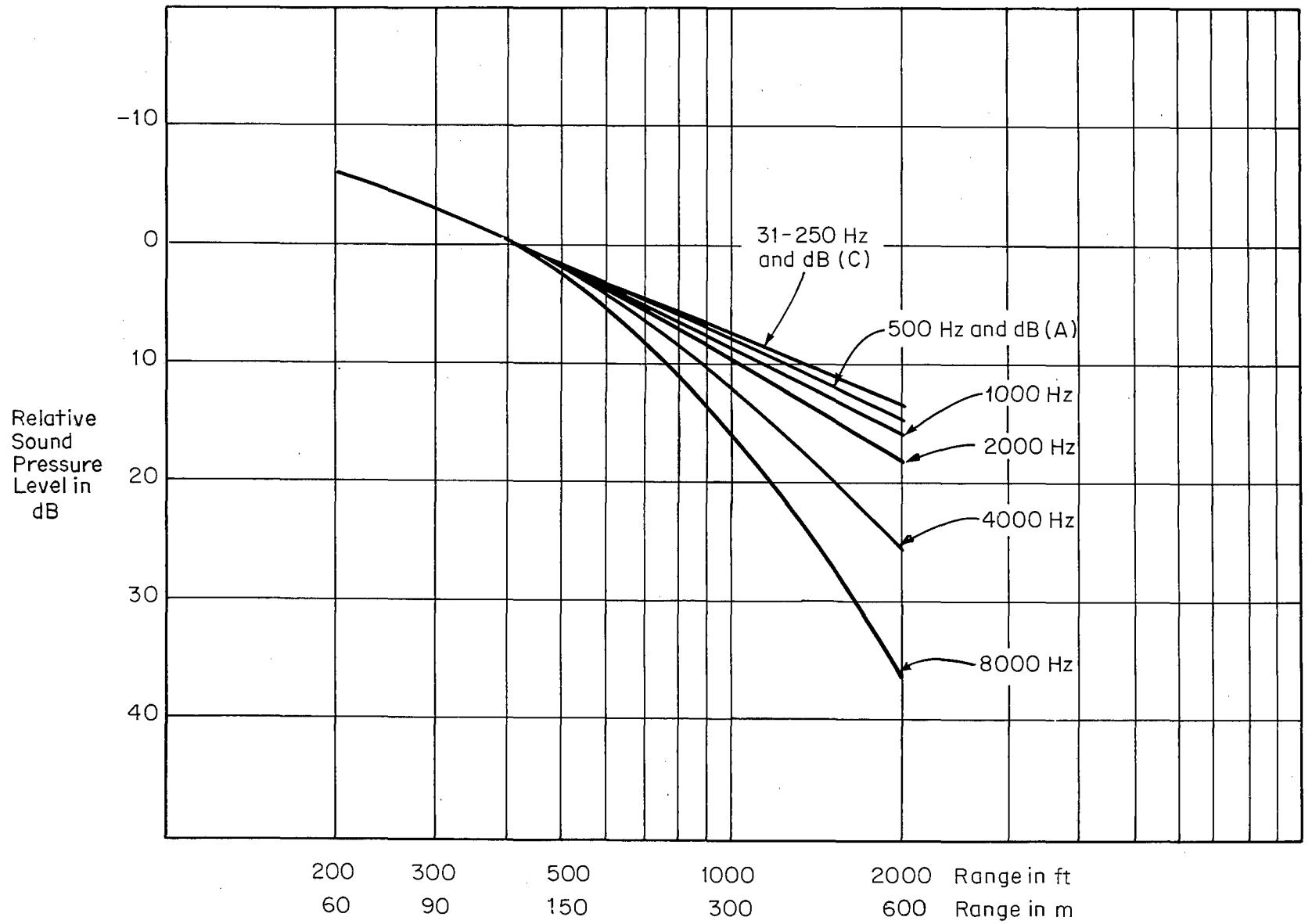


Figure 1

Sound Level Relative to that at 400 ft (120m) for Sound Measured in Octave Bands and Weighted with Networks

Not for Resale

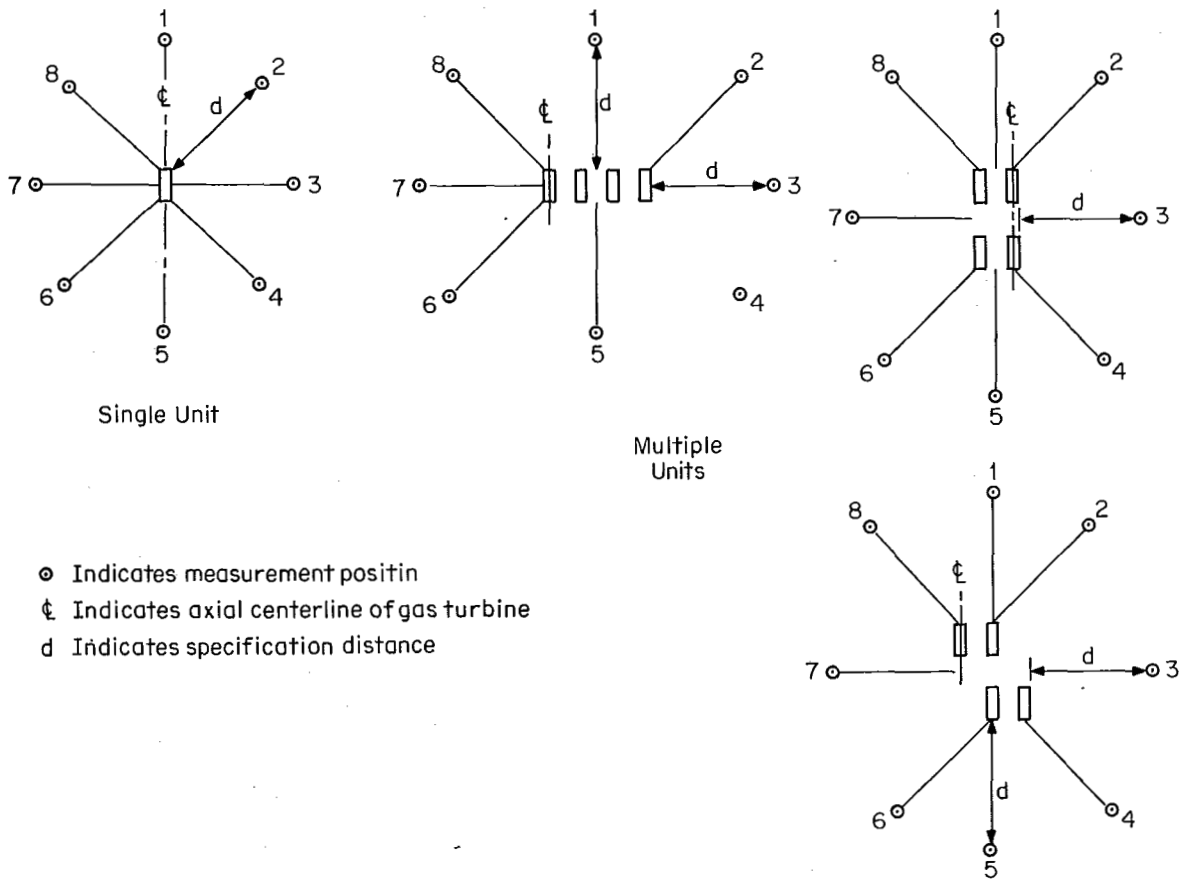


Figure 2

Gas Turbine Sound Level Measurement Locations

Copyright ASME International
Provided by IHS under license with ASME
No reproduction or networking permitted without license from IHS

Not for Resale

APPENDIX A

GUIDE TO DETERMINE ACCEPTABLE A-WEIGHTED SOUND LEVEL

This Appendix is not a part of American National Standard B133.8 but is included for information purposes only.

This Appendix suggests a procedure which may be used to select acceptable A-weighted gas turbine sound emissions for an installation site where there is a nearby community. It may be used to develop procurement sound level specifications; or alternatively, if previously established sound level limits such as property line noise regulations are to be used as a design goal, the expected community subjective response to the noise can be predicted. Use has been made of available information regarding community response to noise (See References 1, 2 and 3 at end of Appendix B). However, community response criteria relates to average group response, and in some cases individual judgments may vary as shown by Figure A1. Therefore, some degree of uncertainty is inherent in this procedure.

Use of this Appendix requires anticipation of the gas turbine installation operation cycle, and a familiarity with the proposed site and its surrounding neighborhood. Special consideration may be required for sites with unusual topographic or demographic features. The procedure described should be followed for each proposed gas turbine installation location. For those installations where noise may have an environmental impact, or there are unusual topographic or demographic features, professional advice may be needed.

Two community sound emission limits are calculated: one for turbines which do not emit prominent discrete tones,[1] and one for turbines which emit prominent tones. The user may want to reference both values in the bid specifications, so that a prospective manufacturer can identify which specified noise level is appropriate to his offering. The manufacturer should be required to state whether or not the sound emissions from his plant include a prominent discrete tone.

Sound specifications apply to the sound emissions from an entire installation, and not to the individual turbines in a multiple array.

Table A1 is a step-by-step work sheet for selecting an acceptable A-weighted community sound level for a complete gas turbine installation. The A-weighted sound level may be calculated by completing the following steps, and entering the results in the appropriate boxes on the worksheet of Table A1:

Step 1. An expected community subjective sound acceptance response category is selected on Figure A1 (ordinate) and the corresponding normalized Outdoor Day/Night Sound Level $(L_{dn})^2$ is determined.

Step 2. Corrections are then obtained from Tables A2 and A3 for the season of operation and the ambient sound characteristics of the nearby neighborhood, and Table A4 for the expected daily operational cycle of the gas turbine installation.

Step 3. The corrections from Step 2 are then summed, and added to the normalized L_{dn} criteria to yield the gas turbine sound level in db(A) at the selected community location, usually the closest neighbor.

Step 4. By reference to Figure A2, determine the correction, in dB, for the distance between the nearest residential area and the standard sound specification distance of 400 ft (120m).

Step 5. Add the distance correction factor from Step 4 to the sound level in dB(A) of Step 3 to obtain the sound level in dB(A) at 400 ft (120m).

Step 6. Add a correction of -5 dB(A) to level calculated at 400 ft (120m) (Step 5) if the turbine sound emissions contain one or more prominent discrete tones.

(This procedure should be repeated for other noise sensitive locations that surround the proposed site, and the most stringent noise emission requirement would be used in Step 7).

Step 7. Enter the calculated A-weighted sound level in dB(A) from Step 5 or 6 as the A-weighted specification sound level for Procedure A, Table 1A (see 2.2.1).

[1] For the purpose of this Procedure, a prominent discrete tone is taken to be as defined in Appendix A of ANSI S1.13, "Methods for the measurement of Sound Pressure Levels," with the quantity "X" equal to 10 decibels. Actually, "X" may range from 5, for more critical installations, to 15 for less critical installations.

[2] L_{dn} designates the day/night sound level, which is the equivalent A-weighted sound level during a 24-hour time period with a 10 decibel weighting applied to the equivalent sound level during the nighttime hours of 10 p.m. to 7 a.m.

Copyright ASME International
Provided by IHS under license with ASME
No reproduction or networking permitted without license from IHS
Not for Resale

Table A1

Suggested Procedure To Develop Sound Level Specification At Standard Distance Of 400 ft (120m)

Steps	Value	Obtain Value From
1. Choose appropriate Value of Normalized outdoor Day/Night Sound Level at nearest residence.	_____dB	Refer to Figure A1
2. Enter corrections:		
a. Seasonal		Refer to Table A2
b. Background sound _____		Refer to Tables A2 and A3
c. Operational cycle _____		Refer to Table A4
Sum of corrections	+ _____ dB	
3. (Value in line 1) + (sum of corrections in line 2) = recommended sound level at nearest residence.	+ _____dB(A)	
4. Enter distance correction in dB(A)	_____dB(A)	Refer to Figure A2
5. (Value in line 3) + (value in line 4) = specification level at 400 ft (120m) for installations without prominent discrete tones.	_____dB(A)	
6. (Value in line 5) -5 dB = specification level at 400 ft (120m) for installations having one or more prominent discrete tones.	_____dB(A)	
7. Specify the appropriate values in Line 5 or 6 in Procedure A, Table 1A (see 2.2.1).		

Copyright ASME International
Provided by IHS under license with ASME
No reproduction or networking permitted without license from IHS
Not for Resale

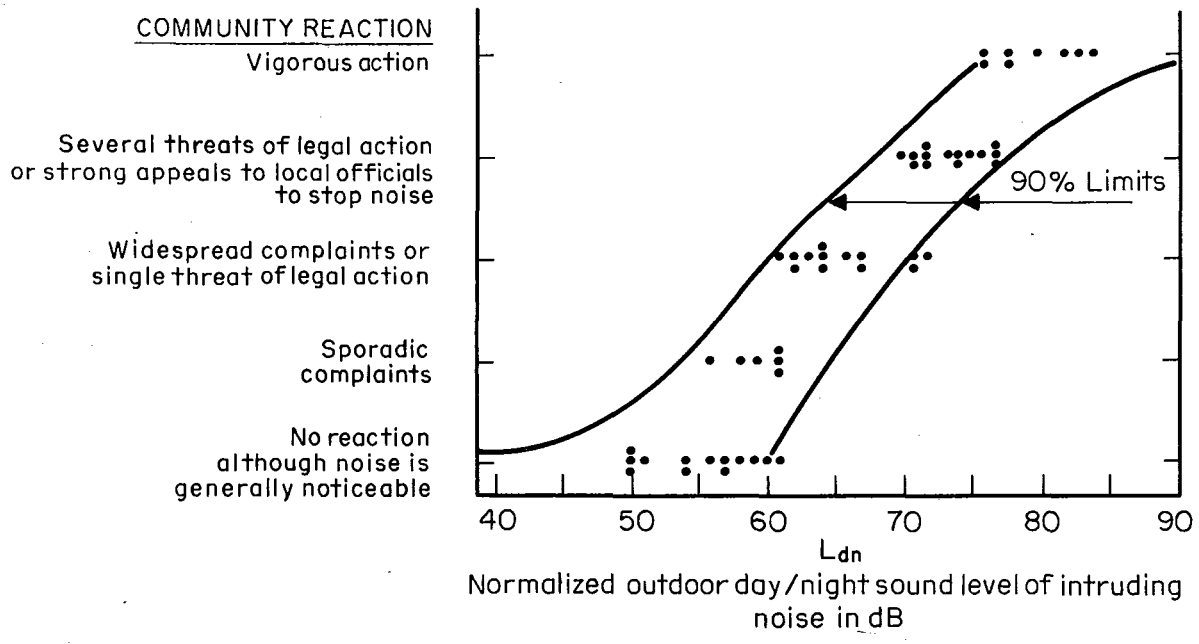


Figure A1

Community Reaction to Noises of Many Types as a Function of the Normalized Outdoor Day/Night Sound Level of the Intruding Noise

Copyright ASME International
Provided by IHS under license with ASME
No reproduction or networking permitted without license from IHS
Not for Resale

Table A2

Corrections For Background Sound

Type of Correction	Description	Amount Correction
Seasonal	Summer (or year-round operation)	0
	Winter only (or windows always closed)	+5
Background[1] Sound	Quiet suburban or rural community (remote from large cities and from industrial activity and trucking)	-10
	Normal suburban community (not located near industrial activity)	-5
	Urban residential community (not immediately adjacent to heavily traveled roads and industrial areas)	0
	Noisy urban residential community (near relatively busy roads or industrial areas)	+5
	Very noisy urban residential community	+10

Table A3

Residential Area Sound Levels[1]

	Daytime Sound Level Exceeded 90% of the time (add 5dB to estimate median sound level)	
Description	Typical Range	Average
Very Quiet Rural Area	31 to 35 inclusive	33
Quiet Suburban Residential	36 to 40 inclusive	38
Normal Suburban Residential	41 to 45 inclusive	43
Urban Residential	46 to 50 inclusive	48
Noisy Urban Residential	51 to 55 inclusive	53
Very Noisy Urban Residential	56 to 60 inclusive	58

[1] These corrections are based on reported typical residual noise levels as shown in Table A3. If measured data at the site under investigation differs significantly from the table, different corrections may be warranted. The residual sound level is that sound level exceeded 90% of the time.

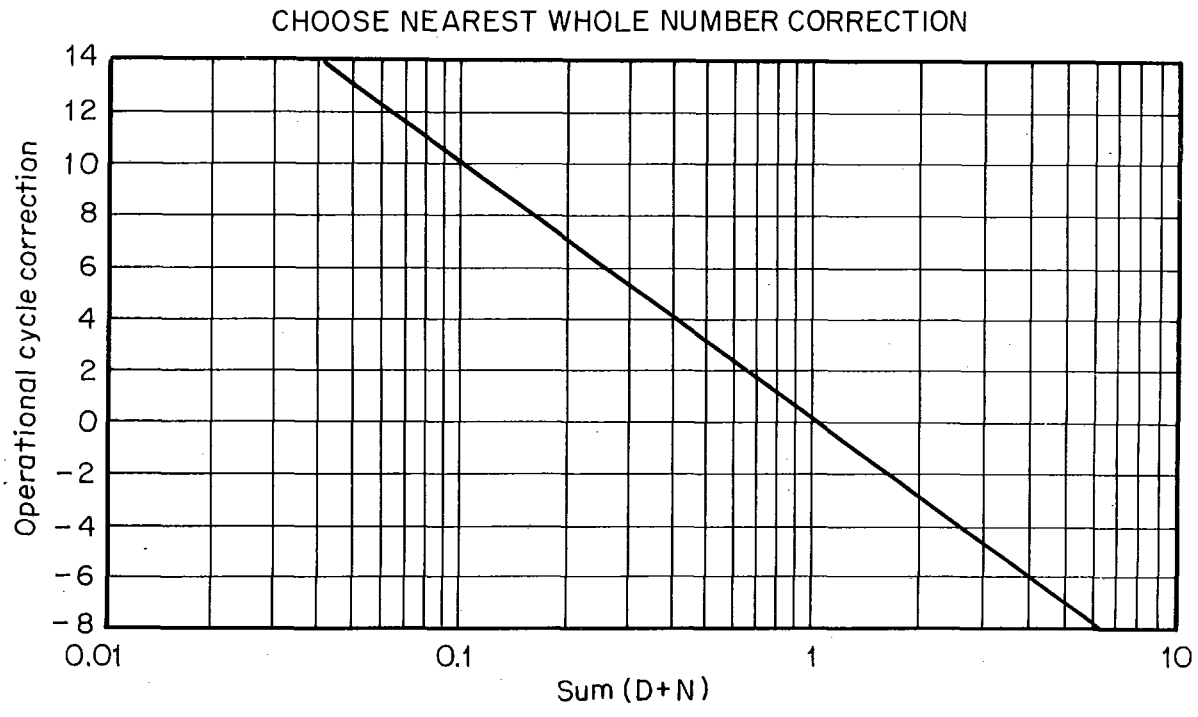
[2] Source: U.S. Environmental Protection Agency Report NTID 300.3, "Community Noise" (December 1971).

Copyright ASME International
Provided by IHS under license with ASME
No reproduction or networking permitted without license from IHS
Not for Resale

Table A4

Operational Cycle Correction

Typical Number of Hours Operation Between 7 a.m.–10 p.m.	D	Typical Number of Hours Operation Between 10 p.m.–7 a.m.	N
0	0	0	0
1	0.04	1	0.42
2	0.08	2	0.83
3	0.13	3	1.3
4	0.17	4	1.7
5	0.21	5	2.1
6	0.25	6	2.5
7	0.29	7	2.9
8	0.33	8	3.3
9	0.38	9	3.8
10	0.42		
11	0.46		
12	0.50	D =	
13	0.54	N = _____	
14	0.58	SUM	
15	0.63		



Copyright ASME International
Provided by IHS under license with ASME
No reproduction or networking permitted without license from IHS
Not for Resale

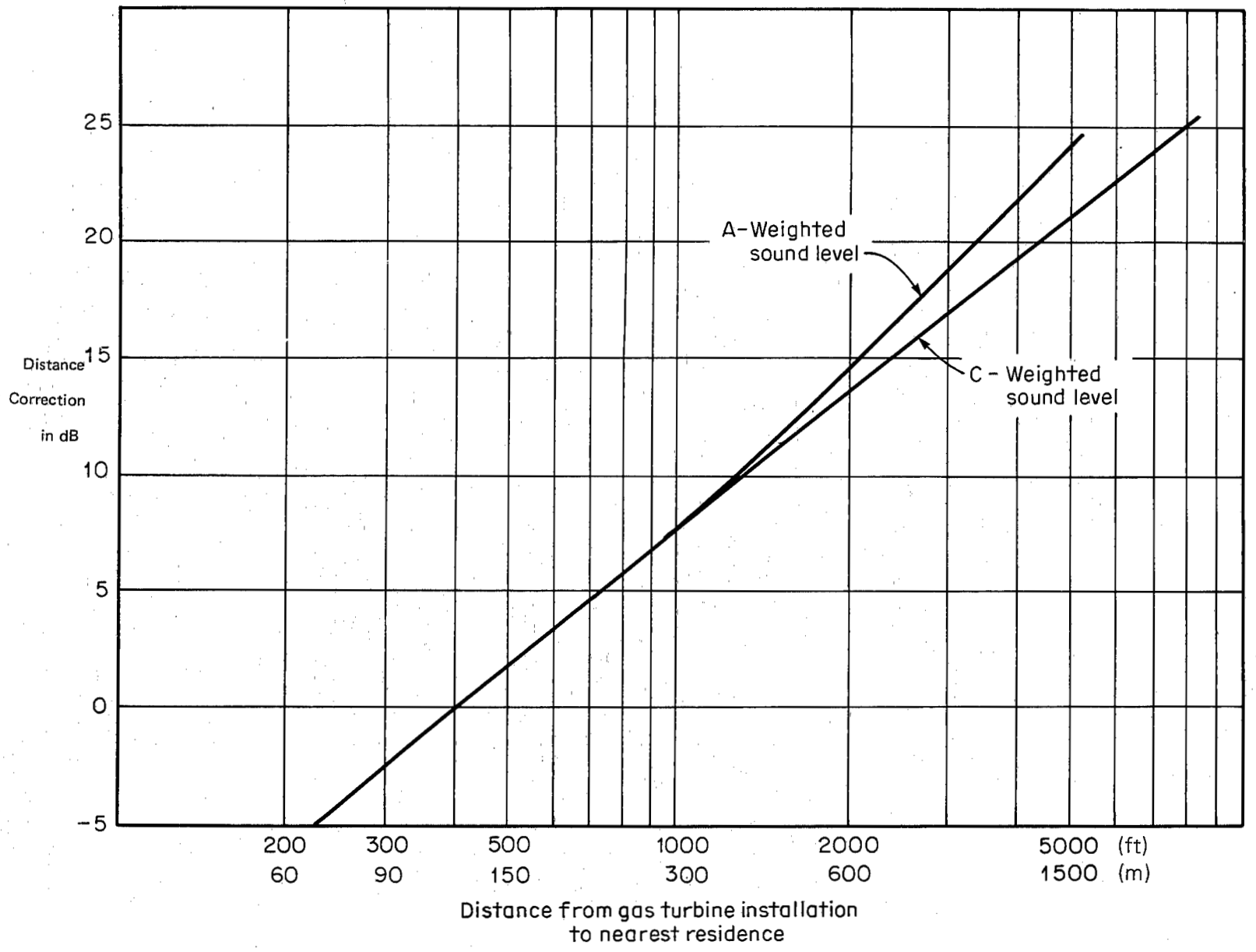


Figure A2

Distance Correction for Weighted Sound Levels (choose nearest whole number)

Copyright ASME International
Provided by IHS under license with ASME
No reproduction or networking permitted without license from IHS
Not for Resale

APPENDIX B

GUIDE TO DETERMINE SPECIFIED C-WEIGHTED SOUND LEVEL

The sound level specified for Procedure A (see 2.2.1) must also include a C-weighted level for gas turbine installations located near occupied frame structures to avoid complaints of building vibration caused by low frequency airborne sound (see reference 6).

The first step in this procedure is to select a maximum value for the C-weighted sound level outside the nearest occupied frame structure. The upper limit for this C-weighted level at the nearest frame structure should be selected not to exceed 75 to 80 dB(C). The range of values is given because there is some uncertainty as to the sound level required to induce structural vibration in a frame structure.

After selecting an appropriate C-weighted sound level, the second step is to find a distance correction from Figure A2 which is added to it to obtain the C-weighted sound level at the specification distance at 400 ft (120m). As an example, for a selected sound level of 75 dB(C) at a residence at 1000 ft (300m) from the gas turbines, the specified level at 400 ft (120m) should not exceed 83 dB(C). This calculated C-weighted level at 400 ft (120m) is entered into Table 1A for the specification in Procedure A (see 2.3.1).

References for Appendices

1. "Community Noise," U.S. Environmental Protection Agency, NTID 300.3, December 31, 1971.
2. "Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety," U.S. Environmental Protection Agency, 550/9-74-004, March 1974.
3. K. M. Eldred, "Assessment of Community Noise," Noise Control Engineering, Vol. 3, No. 2, September-October 1974.
4. L. L. Beranek, "Noise and Vibration Control," McGraw-Hill, New York, pp. 164-193 (1971).
5. R. B. Tatge, "Effect of Community Population on the Applicability of Noise Rating Procedures," Noise Control Engineering, Vol. 4, No. 1, January-February 1975.
6. R. M. Hoover, "Beware Low-Frequency Gas-Turbine Noise," Power, pp. 87-88, May 1973.

Copyright ASME International
Provided by IHS under license with ASME
No reproduction or networking permitted without license from IHS
Not for Resale

AMERICAN NATIONAL STANDARDS FOR GAS TURBINES

TITLE OF STANDARD	
Gas Turbine Terminology (in preparation)	B133.1
Gas Turbine Engine (in preparation)	B133.2
Gas Turbine Auxiliary Equipment (in preparation)	B133.3
Gas Turbine Control and Protection Systems (in preparation)	B133.4
Gas Turbine Electrical Equipment (in preparation)	B133.5
Gas Turbine Ratings and Performance (in preparation)	B133.6
Gas Turbine Fuels, 1977	B133.7
Gas Turbine Installation Sound Emissions, 1977	B133.8
Gas Turbine Emissions (in preparation)	B133.9
Gas Turbines—Information to be supplied by User and Manufacturers (in preparation)	B133.10
Gas Turbines—Shipping and Installation (in preparation)	B133.11
Gas Turbine—Maintenance and Safety (in preparation)	B133.12
Gas Turbine Marine Applications (in preparation)	B133.16
Gas Turbine Power Plants, 1966 (R1973) (Approved as an American National Standard in 1974)	PTC 22

The ASME Publications Catalog shows a complete list of all Standards published by the Society.



Copyright ASME International
Provided by IHS under license with ASME
No reproduction or networking permitted without license from IHS
Not for Resale